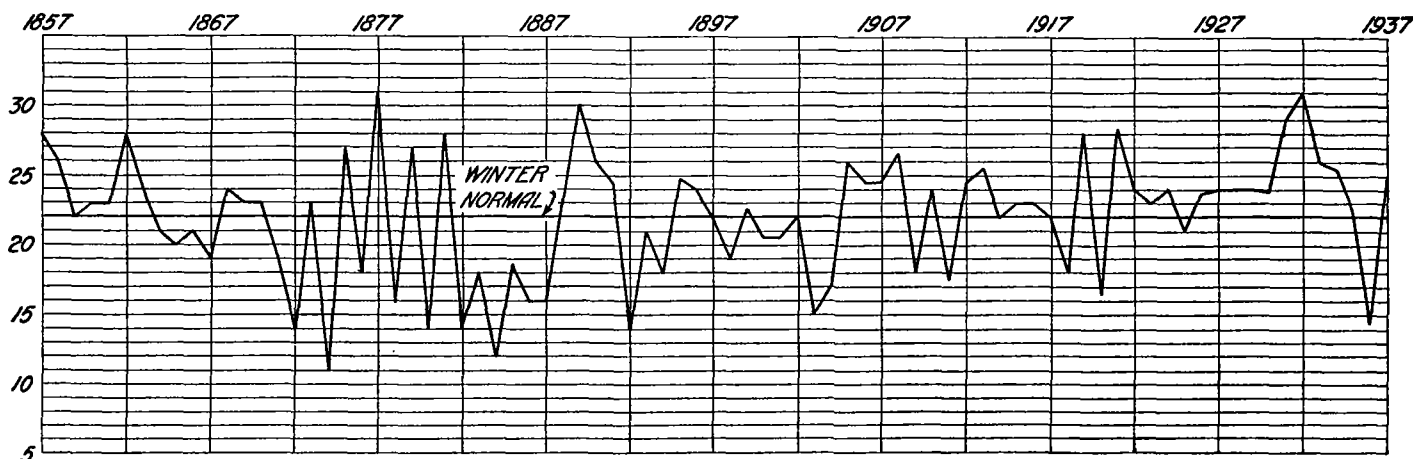


changed during that time. Marengo is consistently colder than Walnut, being farther north. From these comparisons, it is found that the average difference between

and 0.6° for the winter period. It appears then that this warmer tendency after 1917 was real, and not due to the change of location and exposure.

WINTER TEMPERATURES ($^{\circ}$ F) DEC.-JAN.-FEB. AT MARENGO, ILLINOIS



Marengo and Walnut was greater after the change, rather than smaller. The amount of this greater difference was 0.6° for January, 0.2° for February, 0.8° for December,

The writer desires to express appreciation of the kindness of the present Illinois section director, E. W. Holcomb, in furnishing temperature data for Marengo.

RELATION OF RECENT GLACIER RECESSIONS TO PREVAILING TEMPERATURES

By J. B. KINCER

[U. S. Weather Bureau, Washington, November 1939]

The 1939 volume of the Transactions of the American Geophysical Union contains a report by the Committee on Glaciers, Francois E. Matthes, chairman, on the fluctu-

been a marked tendency to relatively high temperatures since the turn of the century. The following paragraphs are quoted from the report of the Committee:

WASHINGTON, D.C. DEPARTURE FROM NORMAL TEMPERATURE

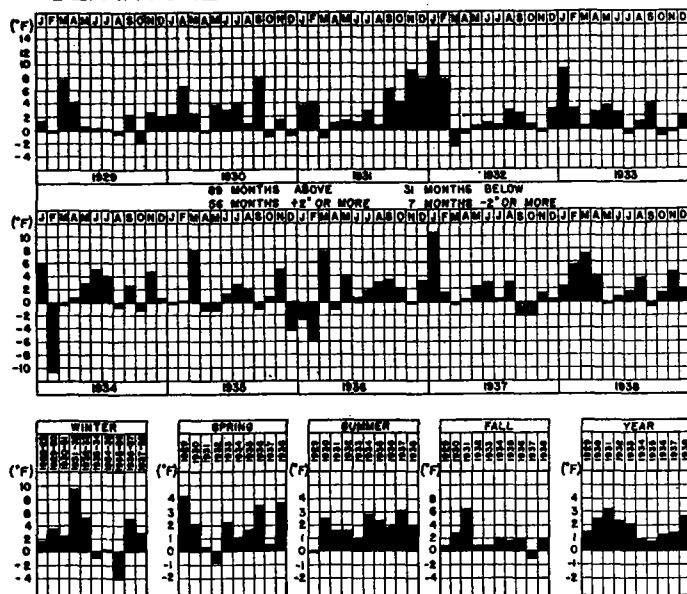


FIGURE 1.

tuations of glaciers, with particular reference to recent recessions. This report is of more than passing interest in connection with the now recognized occurrence of comparatively long-time temperature trends. There has

The systematic measuring of glacier-oscillations from year to year has now been carried on in this country since 1931 (in one locality since 1918); in Europe it was inaugurated in 1894 and has been carried on continuously ever since, except for the unfortunate intermission that was caused by the World War. The value of the records obtained is not to be gaged by the variations indicated in any one year, or group of years, for such passing variations reflect merely the effects of short-time fluctuations in precipitation and temperature, and of various local factors as well. Taken collectively, however, in relation to long-time swings in climatic conditions comprising decades, centuries, and even thousands of years, they are found to possess great significance. That fact has long been recognized and, as a consequence, more than one glaciologist has been spurred on to search for data that would permit extension of the plotted curves back into historic times and even farther back into the past.

Successful searches made in the archives of the town of Chamonix, at the foot of the Mont Blanc Chain (Charles Rabot, *Récents travaux glaciaires dans les Alpes françaises*, La Géographie, v. 30, pp. 257-268, 1915), notably have served to extend the record for the glaciers of the French Alps back to 1580 and for the first time have made it clear that the general recession of those glaciers, which has been in progress during the last few decades, set in shortly after the middle of the nineteenth century. Previous to this there had been an epoch of relatively great glacier-extension that lasted, with minor fluctuations, about 250 years. The glaciers of the French Alps, therefore, are now merely receding back to the positions which they occupied toward the end of the sixteenth century.

More recently Thorarinsson, by searching old records in Iceland, has succeeded in tracing the history of glacier-oscillations on that island back to the year 875, when the Norsemen established their first colonies. This history, significantly, reveals that the present recession of the Iceland glaciers also began shortly after the middle of the nineteenth century (Sigurdur Thorarinsson, *Gröðsschwankungen der Gletscher in Island*, Trans. Internat. Comm. - missions of Snow and of Glaciers, Washington, 1939).

Doubtless it is no mere coincidence that recent observations by Munday on the great Klinaklini and Franklin glaciers in British Columbia, show that these glaciers also are receding from a maxi-

mum advance that must have occurred shortly after the middle of the nineteenth century. And the record of the Nisqually Glacier, on Mount Rainier, which reaches back to 1857, is of a closely similar nature. (W. A. Don Munday, 'The last advance of the glaciers in the Coast Mountains of British Columbia, Trans. Internat. Commissions of Snow and of Glaciers, Washington, 1939)

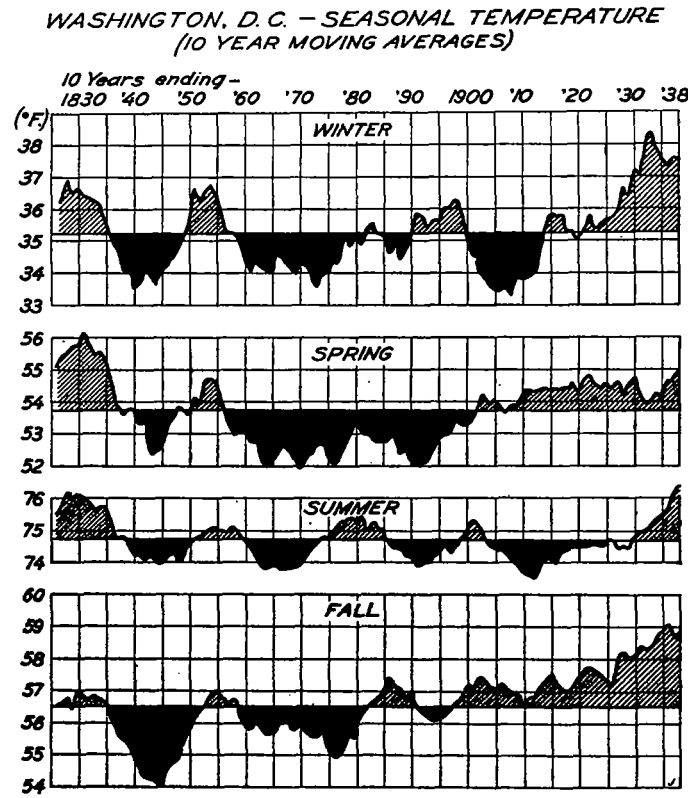


FIGURE 2.

Our longest weather records, extending back in some cases to the latter part of the eighteenth century, show conclusively that since about the middle of the nineteenth century, corresponding to the beginning of the current glacier recession indicated in the report, there has been a

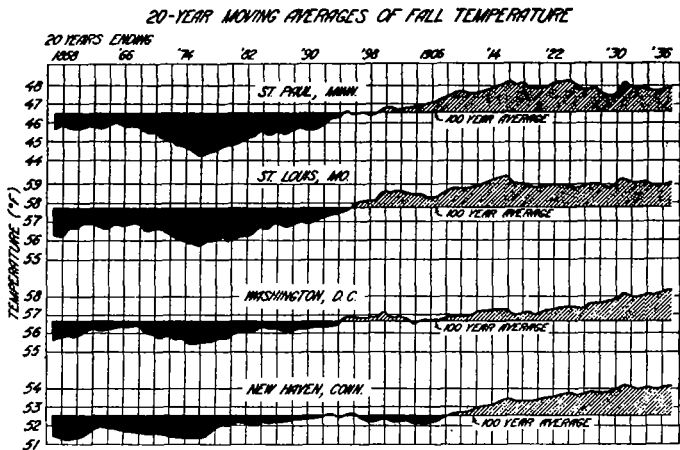


FIGURE 3.

marked tendency to higher temperatures than formerly, the upward trend being especially marked during the last few decades. These temperature trends are shown graphically in the accompanying illustrations.

Figure 1 shows for Washington, D. C., the departure of temperature from normal, month by month and season

by season, for the decade 1929-38. For these 10 years, 75 percent of the 120 months had above normal temperature, 90 percent of the 40 seasons were warmer than normal, and for the year as a whole there was not a single minus departure of temperature.

DEPARTURE FROM NORMAL TEMPERATURE
COLDER HALF OF YEAR (OCT.-MAR.)

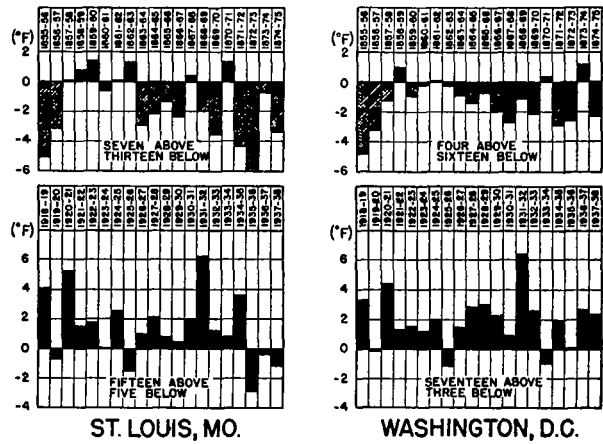


FIGURE 4.

Figure 2 shows seasonal trends for Washington by 10-year over-lapping, or moving, averages, the record covering about 120 years. The rise in temperature of the fall season has been especially marked, as shown in figure 3. As this graph represents a 20-year moving

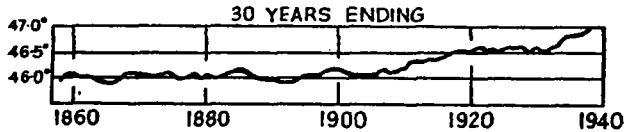


FIG. 1.—THE MARCH OF TEMPERATURE IN WEST EUROPE 1830-1938.

The 30 year moving average from the combined means at: Edinburgh, Oxford, Greenwich, De Bilt, Bergen, Oslo, Stockholm, Copenhagen, Wilno and Berlin.

FIGURE 5.

average, the data actually center 10 years before the dates shown, so that the beginning of the rise agrees well with the beginning of the glacier recessions.

Figure 4 compares the departures from normal for the cold half-year, October-March for the 20 years, 1855-56 to 1874-75, with the last 20 years.

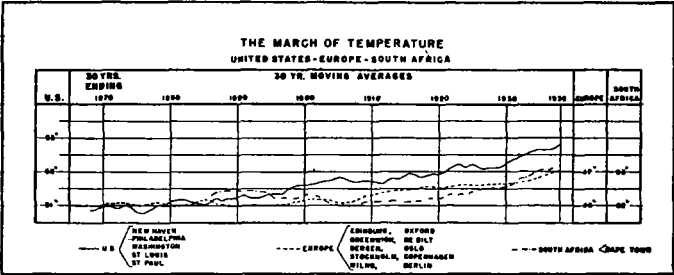


FIGURE 6.

Figure 5 is reproduced from "The Composition of the Atmosphere through the Ages," by G. S. Callendar, Imperial college of Science, London, England, published in the Meteorological Magazine for March 1939. It shows for Europe a recent general trend to higher temperatures, especially marked since the turn of the century in accord with findings in the Western Hemisphere.

For purposes of comparison we have also reproduced Callendar's graph in figure 6 and plotted in conjunction therewith a composite annual temperature curve for the United States, and another for a single station (Capetown) in South Africa. There is close agreement among these,

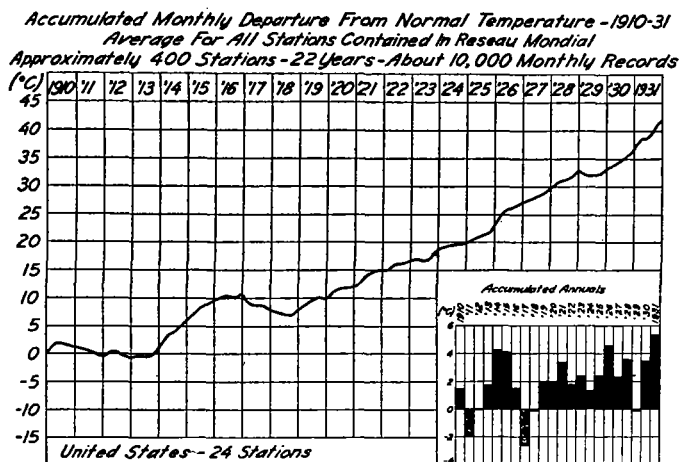


FIGURE 7.

but it will be noted that the rise has been more pronounced in the United States than in either Europe or South Africa.

There is further conclusive evidence that this trend to higher temperature has been general over the globe. Summaries of monthly records published in the Réseau Mondial, containing records for about 400 well distributed stations throughout the world, for the 22 years from 1910

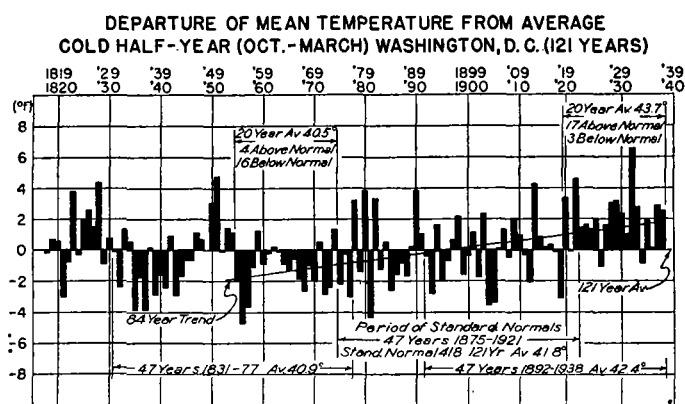


FIGURE 8.

to 1931, show that during this period the world as a whole had subnormal temperatures in only 2 years, approximately normal in 3, and considerably above normal in all the other years. Thus, 80 percent of the years had temperatures decidedly above normal. See figure 7.

In view of these recent relatively high temperatures, the question of the validity of the established Weather Bureau temperature normals naturally arises. The present standard normals are based on the period 1875-1921, which, it will be seen, includes relatively low temperatures in the first part of the period and relatively high in the latter; this fact is illustrated in figure 8 for the cold half-

year of the Washington record, the entire record covering 122 years. The period included in the standard normals averages 41.8° , exactly the same as the average for the entire record. Therefore, the normal sample is representative. It is obvious that a normal computed from the last

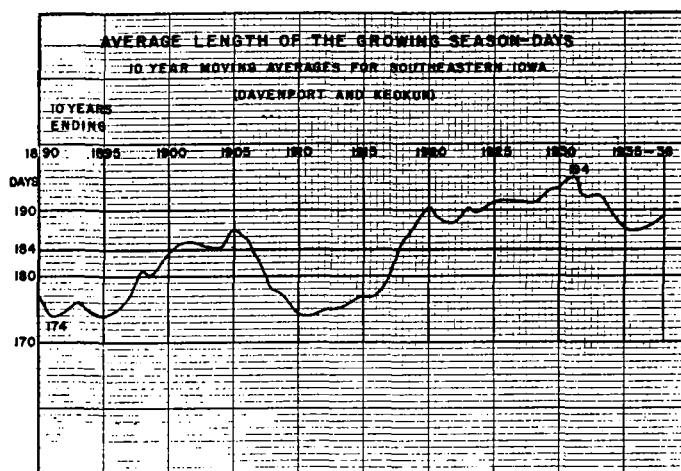


FIGURE 9.

47 years would be too high, and for a like period in the earlier record too low.

This long-time climatic trend has much economic significance, especially agronomic. For example, figure 9 shows that a 10-year average of the length of the crop growing season, represented by the average number of days between the last killing frost in spring and the first

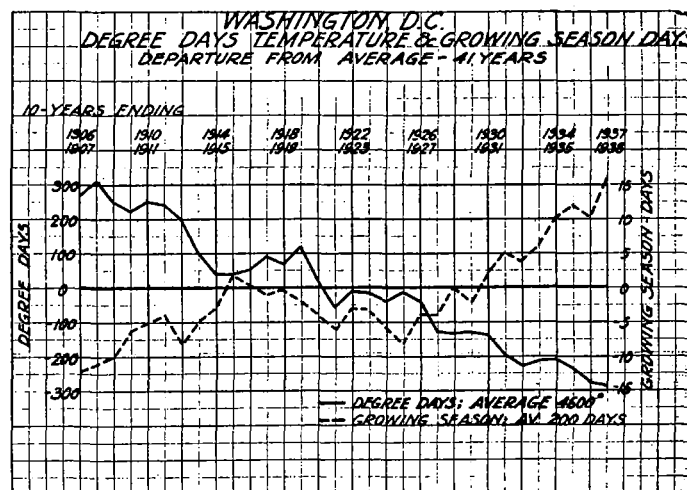


FIGURE 10.

in fall, for southeastern Iowa, in the early thirties was 20 days longer than a like average in the early nineties. Figure 10 shows an even greater lengthening of the growing season in the vicinity of Washington, D. C., with a marked falling off in degree days of temperature. The latter fact means that residents of Washington during the last 10 years have required artificial heat in winter comparable to requirements in south-central Virginia some 40 years ago.